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A new genus and new species of Pupinidae (Gastropoda: Caenogastropoda) from Northern Vietnam

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ABSTRACT. ***Chuatienpupa megacanalis*** gen. et sp. nov. is described from Hoa Binh province, northern Vietnam. ***Chuatienpupa*** gen. nov. is characterized by a small, pupoid-shaped, smooth, glossy shell. Peristome with two canals; anterior canal twisted funnel-shaped, appearing as a very wide groove, opening on the basal side; posterior canal continues vertically upward and forming a wide groove, which is divided by the upper palatal plica. The operculum bowl-shaped, strongly convex, its outer surface smooth, glossy, and covered by a glaze. Both shell and opercular characters distinguish this new genus from other Southeast Asian pupinid genera. General shell morphology of ***Chuatienpupa*** gen. nov. is most similar to *Pupina* Vignard, 1829. However, the new genus differs in having two palatal and basal plicae, a twisted anterior canal, opening on the basal side, and a solid, bowl-shaped operculum, with outer surface dome-shaped and completely smooth.

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Новый род и новый вид Pupinidae (Gastropoda: Caenogastropoda) из северного Вьетнама

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РЕЗЮМЕ. ***Chuatienpupa megacanalis*** gen. et sp. nov. описан из провинции Хоа Бин, северный Вьетнам. ***Chuatienpupa*** gen. nov. характеризуется маленькой, пупоидной, гладкой и блестящей раковиной. Перистом с двумя каналами; передний канал изогнуто-воронковидный, имеет вид широкого желобка, открывающегося на базальной стороне устья; задний канал формирует широкий желобок, разделенный верхней палатальный складкой. Крышечка чашевидная, сильно выпуклая, с гладкой блестящей наружной поверхностью. Признаки раковины и крышечки отличают новый род от других родов пупинид из Юго-Восточной Азии. Общая морфология раковины ***Chuatienpupa*** gen. nov. наиболее схожа с *Pupina* Vignard, 1829, однако новый род отличается наличием двух палатальных и базальной складок, изогнутым передним каналом, открывающимся на базальной стороне устья, твердой чашевидной крышечкой с выпуклой гладкой поверхностью.

Introduction

Vietnam is part of the Indo-Burma Biodiversity Hotspot, which includes Myanmar, Thailand, Laos, Cambodia, Vietnam and southern China [Myers *et al*., 2000; Inkhavilay *et al*., 2019]. The complex topography and hydrology, coupled with the large diversity of habitats and seasonality, are major contributing factors to the high diversity of terrestrial organisms in Vietnam [Sterling *et al*., 2006]. The major part of biodiversity consists of invertebrate biodiversity. This holds true for most ecosystems, including limestone areas in Southeast Asia [Vermeulen, Maassen, 2003].

The family Pupinidae Pfeiffer, 1853 is a distinct group of operculated terrestrial snails characterized by the pupoid or high conical shells, circular aperture, thickened peristome, and most possess aperture devices. The last structure varies from simply by-pass channels formed by internal plicae to snorkel-like tubes, which allow respiration with a closed operculum [Egorov, 2013; Kongim *et al*., 2013; Páll-Gergely *et al*., 2015, 2017]. While most genera possess a smooth shell, in some others they are regularly ribbed [Kobelt, 1902; Chen, 2021; Jirapatrasilp *et al*., 2022]. This family is mainly distributed from East to Southeast Asia, Melanesia,

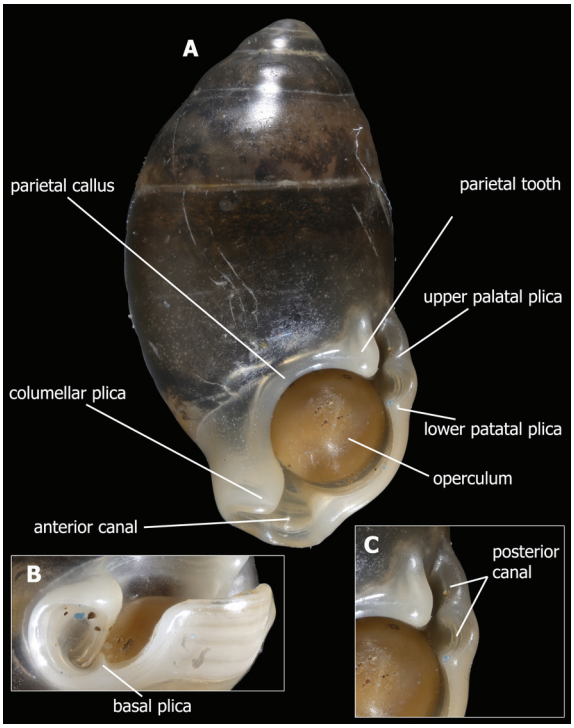

FIG. 1. **A.** General shell morphology of ***Chuatienpupa*** gen. nov. and its terminology. **B.** Details of the anterior canal (bottom view). **C.** Details of the posterior canal.

РИС. 1. **A.** Общая морфология раковины ***Chuatienpupa*** gen. nov. и термины, использованные при ее описании. **B.** Детали переднего канала (вид снизу). **C.** Детали заднего канала.

Micronesia and part of Australia [Vermeulen, Liew, 2022; Jirapatrasilp *et al*., 2022].

To date, the taxonomy of several genera has been reviewed, including *Bellardiella* Tapparone Canefri, 1883, *Coptocheilus* Gould, 1862, *Pollicaria* Gould, 1856, *Pseudopomatias* Möllendorff, 1885, *Rhaphaulus* Pfeiffer, 1856, *Streptaulus* Benson, 1857, *Vargapupa* Páll-Gergely, 2015, etc [Kongim *et al*., 2013; Páll-Gergely *et al*., 2014, 2015, 2019]. However, many genera have not been reviewed, or have been examined in specific geographical areas [Páll-Gergely *et al*., 2019; Jirapatrasilp *et al*., 2022].

Notably, recent publications on the family Pupinidae suggest that terrestrial molluscs fauna of Southeast Asia is still inadequately studied, and there are still many undiscovered species, which can be new to science or new records to the region, especially in limestone areas [Do, 2017; Páll-Gergely *et al*., 2019; Jirapatrasilp *et al*., 2022].

During a field trip to the Chua Tien pagoda, Hoa Binh province in northern Vietnam, a striking group of terrestrial snails was found. The results of the analysis of the specimens revealed that they are new species to science and represent a new genus of Pupinidae. Here, we describe ***Chuatienpupa megacanalis*** gen et sp. nov. from northern Vietnam and discuss its position among the Southeast Asian pupinid genera.

Materials and methods

Counting of the shell whorls (to the closest 0.25 whorl) follows Kerney and Cameron [1979: 13]. The nomenclature for the apertural structure follows Kongim *et al*. [2013], Jirapatrasilp *et al*. [2022]. The shells were measured with digital vernier calipers to the nearest 0.1 mm. Photographs of the shells were taken using a Nikon® Z6 II camera attached with coupled reversed lenses (Nikkor 180mm f2.8 AIS/ Nikkor 50mm f1.8 D). The depth of field (DoF) were stacked from 50 to 80 single photos using Helicon Focus® 7.6.1.

Institutional abbreviations:

HNHM, Hungarian Natural History Museum (Budapest, Hungary).
MNHN, Muséum National d'Histoire Naturelle (Paris, France).
NMR, Natural History Museum Rotterdam (Netherlands).
RBINS, Royal Belgian Institute of Natural Sciences (Brussels, Belgium).
VNMN, Vietnam National Museum of Nature (Hanoi, Vietnam).
ZVNU: Zoological Collection of Biological Museum, VNU University of Science (Vietnam National University, Hanoi), Vietnam.
DDS, Collection of Do Duc Sang (Hanoi, Vietnam).

Photo credits. All images of type specimens of pupinid species used for comparison were received from accessing the museum's official website: MNHN, NMR, RBINS.

Systematics

Superfamily Cyclophoroidea Gray, 1847
Family Pupinidae Pfeiffer, 1853
Subfamily Pupininae Pfeiffer, 1853

Chuatienpupa gen. nov.

Type species – ***Chuatienpupa megacanalis*** sp. nov.

ZooBank registration: urn:lsid:zoobank.org:act:56A18573-7865-4EA3-9731-279EADD65F57

Diagnosis. As in the type species.

Differential diagnosis. ***Chuatienpupa*** gen. nov. is most similar to the genus *Pupina* Vignard, 1829 in general shell and aperture shape, with the presence of canals (anterior and posterior canals). However, this closely related genus lacks the basal plica, and upper palatal plica (some *Pupina* species possesses a homologous structure to the lower palatal plica of the new genus), which divides the posterior canal into two cavities in the new genus. In addition, the

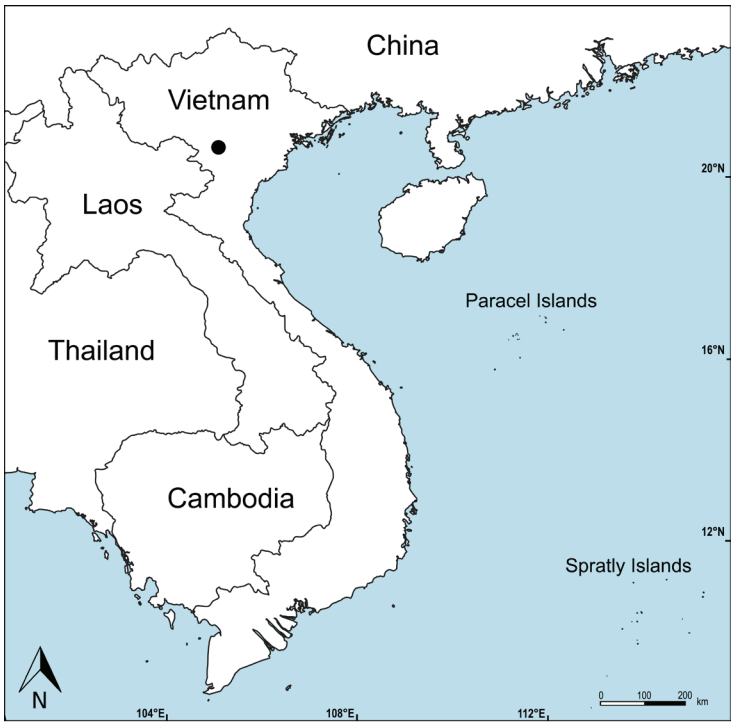

FIG. 2. Map of Vietnam showing the type locality (black dot) of ***Chuatienpupa megacanalis*** gen. nov. et sp. nov.

РИС. 2. Карта Вьетнама с типовым местонахождением (черный кружок) ***Chuatienpupa megacanalis*** gen. nov. et sp. nov.

anterior canal of *Pupina* is narrower and situated on the columellar side. Finally, *Pupina* possesses a circular, thin operculum, outer surface flat and consists of many spirals, while ***Chuatienpupa*** gen. nov. has a solid, closed bowl-shaped operculum, with flat inner, and completely smooth, dome-shaped outer surface (Fig. 1).

Pupinella Gray, 1850 s.l., is somewhat similar to the new genus due to the pupoid shell shape, and the presence of the anterior canal, but the posterior canal of that genus is absent. Species of the subgenus *Pupinella* (*Pupinopsis*) H. Adams, 1866 (type species: *Pupinella swinhoei* H. Adams, 1866) have both canals (anterior and posterior), but differs from the new genus by having a narrower anterior canal, which is situated on the columellar side and lacking both palatal plica and basal plica, a circular, thin operculum, with outer surface flat and consisting of 4 to 5 spirals.

Barnaia Thach, 2017, *Pollicaria* Gould, 1856 and *Rhaphaulus* Pfeiffer, 1856 are similar to ***Chuatienpupa*** gen. nov. in the pupoid shell shape, but differ in the absence of canals, as well as the lack of parietal plica, and a flat, circular operculum (Figs 1, 3–4). The shell of *Pseudopomatias* Möllendorff, 1885 and *Vargapupa* Páll-Gergely, 2015 differs from that of ***Chuatienpupa*** gen. nov. by the spindle shaped with rather regularly ribbed on shell surface, the peristome consists of two circles (most of species), but lacks anterior and posterior canals, the operculum densely coiled, thin and membranous. Both *Coptocheilus* Gould, 1862 and *Tortulosa* Gray, 1847 lack the canals on the peristome, which is present in ***Chuatienpupa*** gen. nov.

Etymology. The name ***Chuatienpupa*** gen. nov. is the combination of the type locality, where the type species was found (Chua Tien pagoda, Lac Thuy district, Hoa Binh province, Vietnam) and *Pupa* (generic name that used to be used for pupoid shaped Pupinidae).

Remarks. ***Chuatienpupa*** gen. nov. is classified in the family Pupinidae due to the smooth sculpture, pupoid shaped and covered by a glaze shell, the presence of two canals at the parieto-angular corner and the basal area.

Chuatienpupa megacanalis sp. nov.
(Figs 1, 2, 3 A–H, 5 A–D)

ZooBank registration: urn:lsid:zoobank.org:act:A729E48F-D0CE-4FBF-BBB0-777E8E8E08A6

Type material. Holotype VNMN-IZ 000.002.331 (shell height 9.1 mm, shell width 4.6 mm, Fig. 3A–E), Vietnam, Hoa Binh province, Lac Thuy district, Phu Lao commune, forests over limestone and limestone hills around the Chua Tien pagoda (20°33.25’N, 105°44.50’E), coll. D.S. Do, 04 February 2022. Paratypes: VNMN-IZ 000.002.332 (2 shells), ZVNU. MOL 047 (3 shells), DDS (8 shells), same data as holotype.

Diagnosis. Shell pupoid shaped, rather solid and glossy. Peristome thickened, not expanded, interrupted by anterior and posterior canals. Posterior canal separated by palatal lip by lower palatal plica, and an additional plica (upper palatal plica) divides posterior canal into two. Columellar area strongly thickened and expanded, with lower part curving into

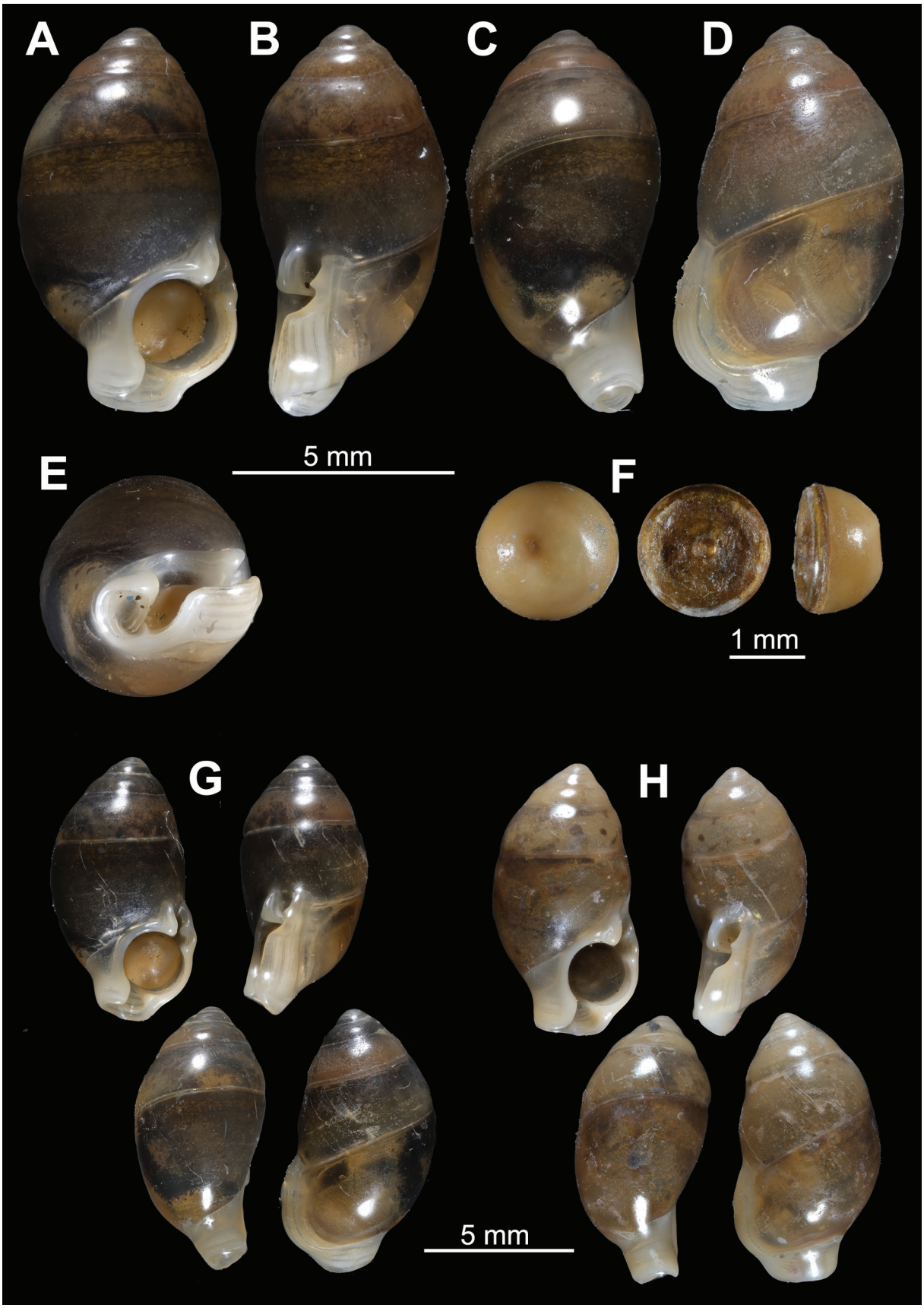

FIG. 3. ***Chuatienpupa megacanalis*** sp. nov. **A–E.** Holotype VNMN-IZ 000.002.331. **F–H.** Paratypes ZVNU.MOL 047. Photos: Nguyen T.S. and Do D.S.

РИС. 3. ***Chuatienpupa megacanalis*** sp. nov. **A–E.** Голотип VNMN-IZ 000.002.331. **F–H.** Паратипы ZVNU.MOL 047. Фото: Нгуен Т.С. и До Д.С.

hook-like plica. Anterior canal very wide, twisted funnel-shaped, and opened on basal side. Operculum outside bowl-shaped, and flat inside.

Description. Shell horny or yellowish, smooth, glossy and slightly transparent, covered by a glaze, pupoid shape with slightly pointed apex. Peristome and its surrounding area clearly distinguished from the other areas by its characteristic ivory colour or transparency. The increase of the whorls is rather regular, slow at the beginning, but suddenly increasing in the last whorls, but not bulging. Shell rather solid, composed of 5–5.5 whorls. Protoconch quite smooth and approximately of 1.5 whorls, although the boundary between the protoconch and the teleoconch is not easily discernible. Suture superficial, margined. The upper whorls moderately bulging, last two whorls less bulging; last whorl occupies more than 2/3 of the total shell height. Aperture circular, slightly oblique and basal part protruding. Peristome complex, thickened, not expanded, and interrupted by two canals: one at parieto-angular corner (posterior canal), and one at basal area (anterior canal). Parietal callus strong, margin slightly elevated and with large parietal tooth. Palatal area quite thickened, the upper part less expanded than on the lower part; the upper part quite concave (observed from lateral view), with two large triangular-like plicae, which are directed toward the parietal plica. Basal area extends obliquely, largely occupied by anterior canal, a strong scythe-shaped plica (basal plica), which seems to bisect the anterior canal (more obvious from basal view). Columella strongly thickened and expanded, lower part curving into hook-like plica (columellar plica) that covers anterior canal. Posterior canal continues vertically upward and forming wide groove divided into two cavities. Anterior canal twisted funnel-shaped, appearing as very wide groove that opens on basal side. Umbilicus closed.

Operculum quite solid, closed bowl-shaped, but hollow inside. Outer surface smooth, glossy, strongly convex, and covered by a glaze. Inner surface flat, slightly smooth, multispiral, with a low nipple on its central. Operculum uniform yellow-orange on outer surface (Figs 1, 3F, 5 A–C).

Living specimens of *Chuatienpupa* ***megacanalis*** sp. nov. has a light grey to light brown body with a pinkish-brown to pale grey head and black tentacles (Figs 5 A–C).

Variability. This species varies slightly in shell dimensions (smallest adult paratype shell is 8.4 mm x 4.3 mm) and in shell color (the most of the specimens are horny or yellowish).

Measurements (in mm)**.** Shell height 8.4–9.3, shell width 4.3–5.0, aperture height 2.6–2.8, aperture width 2.1–2.4, and operculum diameter 1.9–2.0 (n = 14).

Distribution. This species is known from the type locality only.

Etymology. The species name is derived from its characteristic anterior canal, from the Latin words '*mega*', meaning 'large, great' and '*canalis*', meaning 'canal'.

Ecology. This species collected from leaf litter at the foot of limestone rocks with dense disturbed vegetation. Three other pupinid species, *Pupina anceyi* Bavay & Dautzenberg, 1899, *Pupina exclamationis* Mabille, 1887 and *Pupina verneaui* Dautzenberg & Fischer, 1906, were also recorded in the same habitat with the new species.

Remarks. In juvenile shells, as not yet covered by the thick glaze, the sculpture is absent or weak, the palatal plica has not appeared, and the basal area also has not expanded (Fig. 5D).

Discussion

Over last many decades, several authors analysed higher classification and the position of genera or subgenera within Pupinidae but this very interesting topic is not over yet [Kobelt, 1902; Iredale, 1937; Clench, 1949; Egorov, 2013; Páll-Gergely *et al*., 2014]. The classification of the genera or identification of species is often difficult because the diagnostic characters are confused or the boundaries of the genera have changed according to different authors [Kongim *et al*., 2013; Jirapatrasilp et al., 2022].

Prior to this study, *Pupina* was the only recognized genus of the subfamily Pupininae from mainland Southeast Asia, with 31 species and subspecies recorded in this region [Jirapatrasilp *et al*., 2022]. A recent comprehensive revision of the genus is still missing, however partial revision of the genus *Pupina* from mainland Southeast Asia have been already made. Jirapatrasilp *et al*. [2022] proposed three species groups within genus *Pupina* on the basis of the shell teeth (parietal and columellar teeth), canals (anterior and posterior canals) and operculum, namely *P. artata* Benson, 1856 species group, *P. arula* Benson, 1856 species group, and *P. aureola* Stoliczka, 1872 species group.

Genus ***Chuatienpupa*** gen. nov. have been found from the North Vietnam, and is very different from the genus *Pupina*, especially in the canals, shell teeth, aperture plicae and operculum (see Table 1). The results of this study reinforced the fact that Southeast Asia is the known biodiversity center of the family Pupinidae [Páll-Gergely *et al*., 2015; Jirapatrasilp *et al*., 2022].

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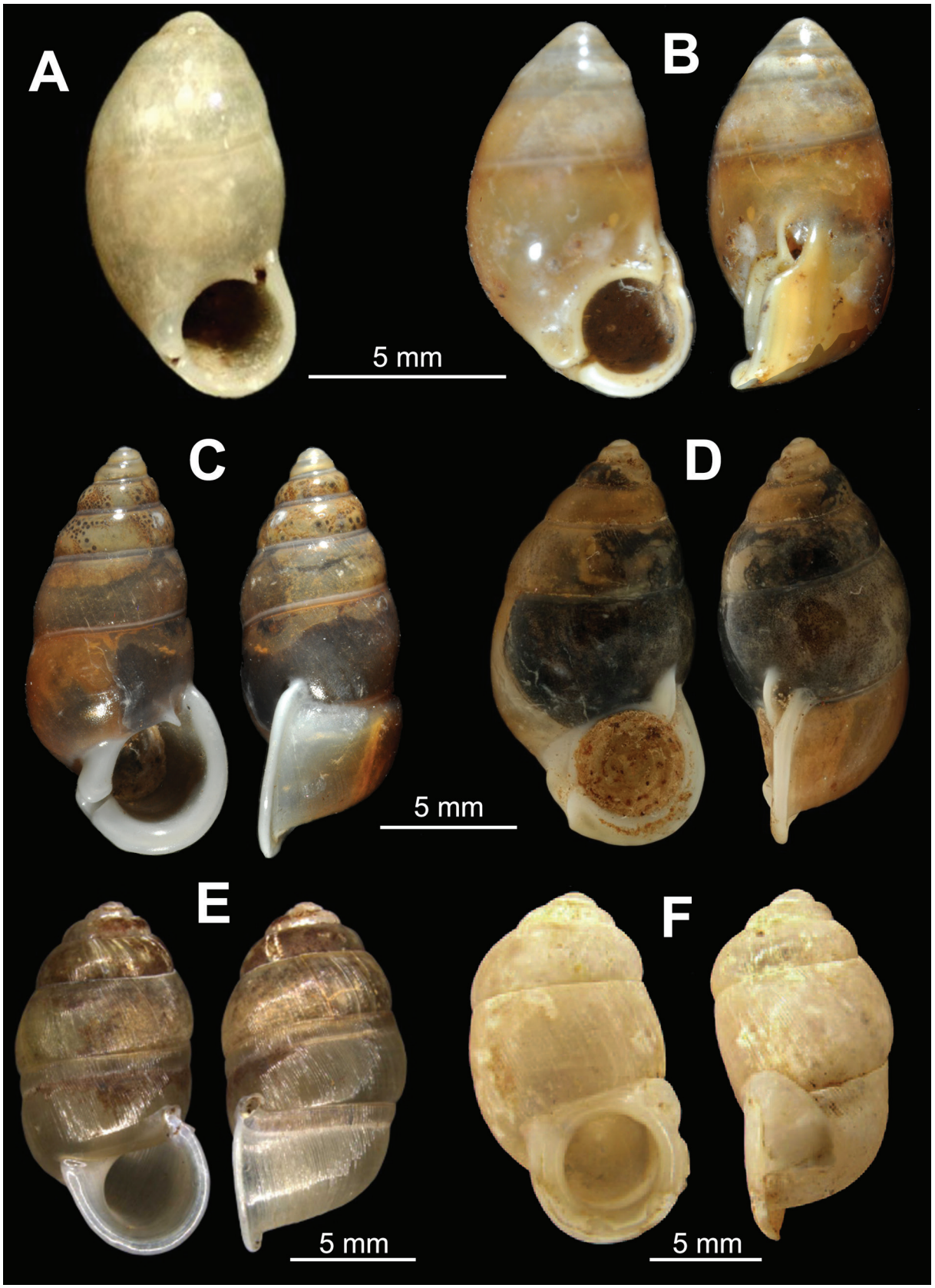

FIG. 4. A. *Pupina keraudrenii* Vignard, 1829 (NMR 178592). B. *Pupina anceyi* Bavay et Dautzenberg, 1899 (syntype MNHN-IM-2000-35833). C. *Pupinella illustris* (Mabille, 1887) (lectotype of *Pupina tonkiniana* Bavay & Dautzenberg, 1899, MNHN-IM-2000-35838). D. *Pupinella mansuyi* (Dautzenberg et Fischer, 1908) (syntype RBINS MT970). E. *Barnaia longituba* (Páll-Gergely et Gargominy, 2017) (holotype MNHN 2012-27162). F. *Rhaphaulus tonkinensis* Páll-Gergely, Hunyadi et Maassen, 2014 (holotype HNHM 98757, from Páll-Gergely *et al*., 2014).

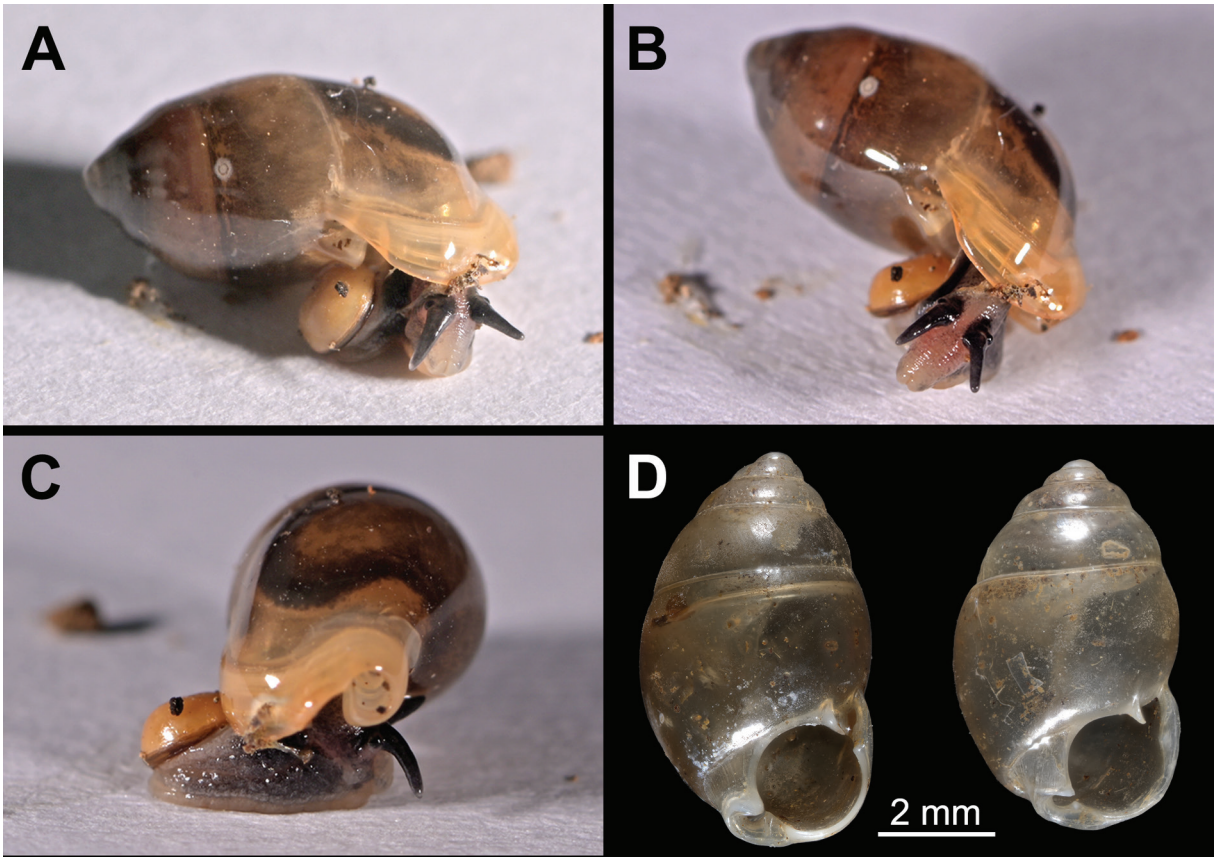

FIG. 5. ***Chuatienpupa megacanalis*** sp. nov., **A–C.** Living specimen (paratype ZVNU.MOL 047). **D.** Juvenile shells. Photos: Nguyen T.S. and Do D.S.

РИС. 5. ***Chuatienpupa megacanalis*** sp. nov., **A–C.** Живая особь (паратип ZVNU.MOL 047). **D.** Ювенильные раковины. Photos: Nguyen T.S. and Do D.S.

Table 1. Shell characters of selected genera of Pupinidae.

Табл. 1. Характеристики раковины избранных родов Pupinidaeю

Name	anterior canal	posterior canal	basal plica	operculum
Chuatienpupa gen. nov.	present, on the basal side	present, divided	present	bowl-shaped, very thick
Pupina	present, on the columellar side	present, not divided	absent	flat, thin
Pupinella (*Pupinella*)	present, on the columellar side	absent	absent	flat, thin
Pupinella (*Pupinopsis*)	present, on the columellar side	present, not divided	absent	flat, thin
Pollicaria	absent	absent	absent	flat, thick
Barnaia	absent	absent	absent	flat, very thin
Rhaphaulus	absent	absent	absent	flat, thin

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(На предыдущей странице) РИС. 4. A. *Pupina keraudrenii* Vignard, 1829 (NMR 178592). B. *Pupina anceyi* Bavay et Dautzenberg, 1899 (синтип MNHN-IM-2000-35833). C. *Pupinella illustris* (Mabille, 1887) (лектотип *Pupina tonkiniana* Bavay & Dautzenberg, 1899, MNHN-IM-2000-35838). D. *Pupinella mansuyi* (Dautzenberg et Fischer, 1908) (синтип RBINS MT970). E. *Barnaia longituba* (Páll-Gergely et Gargominy, 2017) (голотип MNHN 2012-27162). F. *Rhaphaulus tonkinensis* Páll-Gergely, Hunyadi et Maassen, 2014 (голотип HNHM 98757, по Páll-Gergely *et al*., 2014).

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